

SUMMARY OF FOOD HABITS OF AMERICAN GALL MIDGES.

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Our understanding of this group will be much clearer if we recall that it is an offshoot from the Mycetophilidae, the species of which subsist largely upon decaying vegetable matter or low forms of vegetable life. The family Itonidae, better known as the Cecidomyiidae, has attained its present large proportions not by reason of strength, great resistant powers or unusual fecundity, but through an amazing adaptability. We find larvae in decaying vegetable matter, in dead wood, on fungus, affecting all parts of a very great variety of the higher plants and presenting thereupon almost every conceivable grade in the development of the gall, living as parasites at the expense of very small insects or even preying upon their near allies. Broadly speaking, taxonomic studies in this family show at least a moderately close relationship between specialization in structure and divergence in the food habits from those of ancestral forms.

We have no firsthand knowledge of the food habits of the tribe Lestremiinae, though there is every reason to believe that there is substantial agreement in this regard with European species, which have been reared from decaying vegetable matter.

We can supply a little definite information respecting the food habits of the tribe Campylomyzariae, since representatives of several genera have been reared. *Mycophila fungicola*, an undescribed species, referable to a new genus was reared from fungus, while *Monardia lignivora* Felt was obtained in considerable numbers from the fungus-affected heartwood of white pine. *Cordylomyia coprophila* is an undescribed species referable to a genus which will be erected shortly. It was reared from manure. These few records show that this comparatively generalized tribe subsists upon fungi, fungus-affected wood and certain forms of vegetable matter. These food habits agree in general with those of European species, and further observations will doubtless show that members of the tribe as a whole, depend for nourishment on the lower plants or upon the tissues

of the higher plants after invasion by fungi or the commencement of decay.

The subfamily Heteropezinae comprises a number of remarkable, and taxonomically speaking, ancient forms. The species live largely, if not exclusively, in ligneous tissues in the incipient stages of decay. *Miastor* larvae, presumably those of *M. americana* Felt were found in numbers in the moist, partially decayed inner bark and sapwood of chestnut. The majority of the European species studied, develop under practically similar conditions.

Our title implies a limitation to gall-making forms. This is true of the vast majority of the members of this family, though not applicable to the two subfamilies just discussed or to the lowest tribe of the Itonidinae now under consideration. The members of this tribe, the Epidosariae, distinctly allied with the more generalized forms in this family by the presence of a well developed crossvein and yet exhibiting a connection with the higher forms because of the universal presence of highly specialized circumfili, do not produce galls but live in dead, frequently dried, woody tissues. The detection of the larvae is consequently difficult and, as a result, rearings have been comparatively few. *Winnertzia pinicorticis* Felt was obtained by Mr. Pergande from the bark of *Pinus inops*. The genus *Colpodia*, with its remarkably long, narrow wings, probably lives in dead wood, a habit known to be true of *Asynapta saliciperda* Felt which was reared from old *Rhabdophaga batatas* O. S. galls on willow.

The most generalized of the true gall-making forms are probably found in the tribe Dasyneurariae, the genus *Rhabdophaga* Westw. being the less specialized of this group. A study of this genus shows at once a marked partiality to *Salix*, a genus placed rather low in the series of flowering plants, and the production thereupon of a number of comparatively simple deformities such as bud and subcortical galls. It is pre-eminently a genus of the willow. *Dasyneura* Rond. comes next. An examination of the records shows that a large proportion of the species live in comparatively simple leaf and bud galls on various genera of the higher flowering plants, an interesting exception being the remarkable *D. flavotibialis* Felt which was reared from decaying wood, while *D. rhois* Coq. was obtained from a root gall on Sumac. The peculiar *Lasiopteryx*

coryli Felt was reared from leaf folds on hazel, *Corylus virginica*. An undescribed species of *Cystiphora* Kieff. was reared from a very inconspicuous swelling on *Viburnum* leaves. A departure from the normal food habit in this tribe is seen in *Coccidomyia pennsylvanica*, an undescribed species belonging to a new genus and reared from *Lecanium* scales.

This series of generalized gall-making forms is continued in the tribe *Oligotrophiariae*, separated from the preceding only by the simple claws. The more generalized genus, *Phytophaga* Rond. exhibits a connection with the preceding tribe in the possession by *P. destructor* Say., of claws with rudimentary teeth. As is well known, it hardly makes a gall, depending for protection upon the leaf sheath. *P. ulmi* Beutm. occurs in the buds of elm, *P. violicola* Coq. curls the leaves of violet, while several species of this genus typified by *P. rigidae* O. S. live upon *Salix*, making galls similar to those produced by species of *Rhabdophaga*. *Janetiella asplenifolia* Felt was reared from a fleshy fold on the midvein of sweet fern, while *J. brevicauda* Felt was obtained from the typical gall of *Lasioptera vitis* O. S. on grape. The genus *Oligotrophus* Latr. is represented by the European *O. betulae* Winn., which affects the seeds of birch, while *O. salicifolius*, an undescribed species produces a flattish, ovoid gall on *Salix* leaves. The genus *Rhopalomyia* Rubs. contains a large number of species and exhibits a marked partiality for *Solidago*, producing upon various species of this plant genus a considerable number of flower and bud galls, the large rosette deformities of apical buds being characteristic. A few species of this genus also occur upon the allied aster and *Artemisia*. The larger species of *Sackenomyia* Felt are restricted to *Salix*, while one small species at least, has been reared from *Viburnum*. *Walshomyia* Felt is found in the fruit of *Juniperus*.

The tribe *Lasiopterariae* exhibits a high degree of specialization in venation at least, and we find in this group a marked restriction in food habits. The genera *Lasioptera* Meign. and *Neolasioptera* Felt live almost exclusively in subcortical stem galls, a large proportion of the species occurring upon *Solidago*, though a considerable variety of other plants are subject to attack. *Asteromyia* Felt, like the two preceding genera, exhibits a marked preference for *Solidago*, though a number of species occur upon aster. It is noteworthy that a large major-

ity of the galls produced by this genus are of the apparently fungous-affected blister type. The highly specialized *Clinorhyncha* Loew is represented in America by several species probably restricted to the florets of Yarrow, Thoroughwort and presumably *Chrysanthemum*. The peculiar *Camptoneuromyia adhesa* Felt has been reared from oval, adherent galls between *Solidago* leaves, while *C. rubifolia* Felt was obtained from a marginal leaf roll on blackberry.

The tribe *Asphondyliariae* is a rather highly specialized group, the species living mostly in buds. This is particularly true of *Asphondylia* H. Lw., a genus practically confined to buds and apparently not closely restricted in food habits, since different species have been reared from a considerable variety of plants. *Schizomyia* Kieff. is allied to the preceding genus and the several species reared were obtained from buds; such as *S. coryloides* Walsh and Riley from an apical leaf bud gall on grape, and *S. pomum* Walsh and Riley from a nutlike polythalamous grape gall, evidently a modified bud. *S. rivinae* Felt was reared from bud galls on *Rivina*. *Cincticornia* Felt appears to be restricted to leaf galls on *Quercus*, the largest and perhaps most characteristic being that produced by *C. pilulae* Walsh. A series of rearings have resulted in obtaining a number of species, all from various leaf galls on this plant genus.

The tribe *Itonidinariae* comprises a large assemblage of highly specialized forms, easily divided by the circumfili into two groups, namely the bifili and trifili. The former is represented by *Endaphis* Kieff. first recorded as an endoparasite on *Aphididae* and reared by us from mite infested foliage. *Contarinia* Rond. also belongs in this subtribe and, as is well known, displays a marked preference for bud and fruit structures, *C. johnsoni* Sling., *C. virginianae* Felt, *C. rumicis* H. Lw., *C. sorghicola* Coq. and *C. pyrivora* Riley, all being representative in food habit. *Thecodiplosis* Kieff. is closely allied to the preceding and is represented in America by *T. quercifolia* Felt reared from oak, *T. ananassi* Riley reared from a twig gall on *Taxodium*, and *T. liriodenri* O. S., inhabiting a blister gall on tulip leaves. *Dentifibula* Felt, also in this subtribe, has at least one species, *D. cocci* Felt, which is zoophagous.

The subtribe trifili comprises the remainder of the genera in the family. The genus *Bremia* Rond., represented by several American species, is probably phytophagous. *Aphidoletes* Kieff. contains several American species, a few of which at least are known to prey upon Aphididae. It is possible that our American species of *Lobodiplosis* Felt, *Coquilletomyia* Felt, and *Karschomyia* Felt have habits similar to those of the allied *Mycodiplosis* Rubs., the majority of the species of which appear to subsist upon fungi, though one, *M. acarivora* Felt preys upon *Tetranychus*. *Youngomyia* Felt displays a preference for the buds of various plants. Species of *Clino-diplosis* Kieff. have been reared from leaf galls on scrub oak, *Spiraea*, *Carya*, and from roots of *Cattleya*. It is probable that the species occurring on hickory leaves is an inquiline. The genus *Caryomyia* Felt comprises a number of homogeneous forms producing a considerable variety of galls on hickory leaves. We have yet to obtain undoubted evidence that members of this genus live upon any other plant. *Prodiplosis floricola* Felt has been reared from enlarged blossoms of spiraea and clematis. *Arthrocnodax* Rubs. is represented by several American forms, *A. apifila* Felt occurring in bee hives and probably subsisting upon organic debris, though subsequent investigations may show it to be predaceous. *Hormomyia* H. Lw. comprises a number of large forms usually found in the vicinity of swamps and presumably living mostly on sedges or allied vegetation. Four species, hardly typical of the genus, namely *H. crataegifolia* Felt, *H. canadensis* Felt, *H. clarkei* Felt and *H. verruca* Walsh have been reared from leaf galls respectively, on *Crataegus*, *Amelanchier*, *Spiraea* and *Salix*. The European *Monarthropalpus buxi* Lab., producing an oval swelling upon the leaves of Box has been recently detected in this country. *Giardomyia menthae* Felt was reared from a pustule-like gall in the axil of the leaf of *Mentha canadensis*. *Lestodiplosis* Kieff. is represented by a large series of mostly spotted-winged midges which have been reared from a considerable variety of plants. The larvae of some at least, are known to be zoophagous and it is probable that most of the reared American forms prey upon the larvae of gall-making midges. The genus *Itonida* Meign., better known as *Cecidomyia* Meign., comprises a large number of forms inhabiting for the most part, flower, bud and leaf galls on the higher flowering plants, though I.

resinicola O. S. and *I. resinicoloides* Wlms. occur in exuded pitch masses on pine, while *I. tritici* Kirby is well known as a species of prime economic importance.

A study of our records from a botanical aspect reveals several facts of interest. We note first that American gall midges live at the expense of some 177 plant genera belonging to 66 plant families. They afford support to some 538 species of gall midges representing 44 genera. These forms are known to inhabit 44 fruit (botanically speaking), 146 bud, 218 leaf, 130 stem, and 4 root galls. The paucity of root galls must be attributed in a measure to the difficulty of finding them. In addition to the above some five species were reared from unknown plants and eleven zoophagous species belonging to three genera, making a total of 47 insect genera comprising some 554 species, 441 of these having been reared from either plants or animals. Reference to our records shows that the Compositae supports a very large fauna, 22 of its genera affording sustenance to 118 species of gall midges belonging to some 15 genera. The majority of these midges, 55 species occur in bud, 32 in leaf, 30 in stem, while 5 inhabit fruit galls. The Salicaceae, represented only by *Salix* and *Populus*, supports some 59 species of gall midges referable to 15 genera, by far the greater number occurring upon *Salix*. As in the Compositae, a large proportion, 21 species occur in bud, 15 in leaf and 21 in stem galls, only 1 living at the expense of the fruit. The Rosaceae appears to be the next plant family favored by gall midges, 10 genera being subject to attack by 43 species of midges, assignable to 14 genera, 3 species inhabiting fruit, 12 bud, 25 leaf and only 3, stem galls. The Gramineae, despite its numerous genera and wide distribution has but 18 genera at present known to support some 25 species of midges representing 12 insect genera, 8 species occurring in fruit and 17 in stem galls. This is probably only a small proportion of the forms occurring upon grasses. Our record for the Cyperaceae is even more unsatisfactory, only one species, presumably inhabiting a stem gall being known. The paucity of records in both of these families is probably due to the difficulty of finding the galls. There is a close parallelism between the Juglandaceae and the Fagaceae, two genera in each being affected by gall midges. *Juglans* and *Castanea* are known to be infested by one and three species respectively,

while *Carya* and *Quercus* are subject to attack by 25 and 21 species, the former affording support to representatives of 5 and the latter to species belonging to 7 genera. These two trees are likewise comparable in that each supports but one species in the fruit, while by far the greater majority of the midges, namely 23 and 18 respectively, produce leaf galls. The large family Leguminosae has 13 genera which support some 5 genera of gall midges referable to 20 species, 3 living in fruit, 3 in bud, 6 in leaf and 8 in stem galls. Only 6 genera in the Urticaceae are attacked by gall midges belonging to 4 genera representing 8 species, 2 living in bud, 9 in leaf and 6 in stem galls. In the Vitaceae, *Psedra*, and *Vitis* support some 12 genera of gall midges representing 17 species; 4 inhabit bud, 12 leaf and 1 root galls. By far the great majority of the species, 15, occur upon *Vitis*. The large family of Labiatae supports some 6 genera representing only 13 species, the Caprifoliaceae, 8 genera comprising 14 species, and the important Pinaceae 6 genera and 14 species. The above record, while dealing with a much larger number of species than we have been accustomed to think occurred in this family, shows that in all probability there are many forms yet to be discovered.

Comparing the above data with recently summarized records* it will be seen that the food habits of some 420 European gall midges representing 43 genera are unknown. The Pinaceae afford sustenance to 11 species belonging to 4 genera, a condition closely paralleled in this country. The European Gramineae support some 20 gall midges representing 7 genera, a showing somewhat below what obtains in America. Conversely, the European records for the Cyperaceae include 4 genera and 9 species, while in this country but one species has been reared from *Scirpus*. The European Salicaceae supports some 30 species of midges belonging to 6 genera, 5 of these occurring on poplar. There appear to be no species affecting the Juglandaceae in Europe. There are nearly as many genera and species, 20 and 7 respectively, occurring upon the Fagaceae in Europe as in America, though the distribution is different, since *Fagus* supports 5 species referable to 3 genera and *Quercus* has only 14 species representing 4 genera, a marked contrast to conditions obtaining in this country. There is a pronounced differ-

*1909, Houard, C. Les Zooecidies des Plantes d'Europe.

ence in the European Rosaceae, especially marked in Spiraea with its 2 genera and 5 species, contrasting strongly with our 8 genera representing 11 species. A still greater difference is found in the Vitaceae, the European Vitis supporting but 2 genera and 2 species, while our American vines afford sustenance to 12 genera represented by 15 species. The European fauna of the Compositae is also much less, namely some 67 species representing 10 genera as compared with our 118 species assignable to 15 genera. This large discrepancy is accounted for in great part by the enormous fauna of the Solidago and the numerous species occurring upon aster; plant genera which in Europe support only one genus and one species.